

WHAT IS CLAIMED IS:

1. A liquid crystal Fabry-Perot etalon comprising:
  - a first substrate coated on a first side with a first transparent conductor layer;
  - a first reflector layer disposed over the first transparent conductor layer on the first side of the first substrate;
  - an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;
  - a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;
  - plural spacers disposed between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;
  - liquid crystal filled in between the first substrate and the spacer plate; and
  - a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.
2. The liquid crystal Fabry-Perot etalon according to claim 1, wherein the second substrate is spaced a predetermined distance apart from the spacer plate.
3. The liquid crystal Fabry-Perot etalon according to claim 1, wherein the second substrate is disposed directly against the spacer plate.
4. A liquid crystal Fabry-Perot etalon comprising:
  - a first substrate coated on a first side with a first transparent conductor layer;
  - a first reflector layer disposed over the first transparent conductor layer on the first side of the first substrate;
  - an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;
  - a second transparent conductor layer;
  - liquid crystal filled in between the alignment layer and the second transparent conductor layer; and

a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the first side of the first substrate;

wherein the first transparent conductor layer and the second transparent conductor layer are each etched so as to form multiple independent etalons.

5. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched according to a grid pattern.

6. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched according to a wedge pattern.

7. The liquid crystal Fabry-Perot etalon of claim 4, wherein the first and second transparent conductor layers are etched using a laser.

8. The liquid crystal Fabry-Perot etalon of claim 7, wherein the first and second transparent conductor layers are etched using an Nd:YAG laser.

9. The liquid crystal Fabry-Perot etalon of claim 4, wherein each of the multiple independent etalons is independently tunable to different wavelengths.

10. The liquid crystal Fabry-Perot etalon of claim 4, wherein each of the multiple independent etalons comprises as an independently tunable filter.

11. The liquid crystal Fabry-Perot etalon of claim 4, wherein the second transparent conductor layer is coated on the second substrate.

12. The liquid crystal Fabry-Perot etalon of claim 4, further comprising:  
a spacer plate disposed between the first substrate and the second substrate,  
wherein the second transparent conductor layer is coated on the spacer plate.

13. A liquid crystal Fabry-Perot etalon comprising:  
a first substrate formed of glass;  
a spacer plate formed of glass;  
liquid crystal disposed between the first substrate and the spacer plate;

a second substrate formed of glass, spaced apart from the spacer plate by an air gap;

a phase matched glass-liquid crystal interface reflective coating disposed on a first side of the first substrate, the first side of the first substrate facing the liquid crystal;

a first phase matched glass-air interface anti-reflective coating disposed on a second side of the first substrate opposite its first side;

a phase matched glass- liquid crystal interface anti-reflective coating disposed on a first side of the spacer plate, the first side of the spacer plate facing the liquid crystal;

a second phase matched glass-air interface anti-reflective coating disposed on a second side of the spacer plate opposite its first side;

a phase matched glass-air interface reflective coating disposed on a first side of the second substrate, the first side of the second substrate facing a second side of the spacer plate; and

a third phase matched glass-air interface anti-reflective coating disposed on a second side of the second substrate opposite its first side.

**14.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal reflective coating comprises:

a reflector layer disposed on the first side of the first substrate;

a tin-indium oxide transparent conductor layer disposed over the reflector layer;

and

an alignment layer disposed over the tin-indium oxide transparent conductor layer.

**15.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal anti-reflective coating comprises:

a tin-indium oxide transparent conductor layer disposed on the first side of the spacer plate; and

a alignment layer disposed over the tin-indium oxide transparent conductor layer.

**16.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the etalon has an overall transmission characteristic of about 0.95 or greater.

**17.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal reflective coating comprises:

- a tin-indium oxide transparent conductor layer;
- multiple alternating layers of  $\text{MgF}_2$  and  $\text{ZrO}_2$ ; and
- a nylon layer.

**18.** The liquid crystal Fabry-Perot etalon of claim **13**, wherein the phase matched glass-to-liquid crystal anti-reflective coating comprises:

- a tin-indium oxide transparent conductor layer;
- multiple alternating layers of  $\text{TiO}_2$  and  $\text{SiO}_2$ ; and
- a nylon layer.

**19.** An optical wavelength division multiplex device comprising:  
two or more liquid crystal Fabry-Perot etalons connected together in a series combination, wherein each of the liquid crystal Fabry-Perot etalons comprises:

- a first substrate coated on a first side with a first reflector layer;
- a first transparent conductor layer disposed over the first reflector layer on the first side of the first substrate;
- an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;
- a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;
- plural spacers disposed between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;
- liquid crystal filled in between the first substrate and the spacer plate; and
- a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.

**20.** The optical wavelength division multiplex device according to claim **19**, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is spaced a predetermined distance apart from the spacer plate.

**21.** The optical wavelength division multiplex device according to claim 19, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is disposed directly against the spacer plate.

**22.** An optical cross-connect comprising:

a pair of optical wavelength division multiplex devices connected via an optical network, wherein each of the optical wavelength division multiplex devices comprises:  
two or more liquid crystal Fabry-Perot etalons in series combination, wherein each of the liquid crystal Fabry-Perot etalons comprises:

a first substrate coated on a first side with a first reflector layer;

a first transparent conductor layer disposed over the first reflector layer on the first side of the first substrate;

an alignment layer disposed over the first transparent conductor layer on the first side of the first substrate;

a spacer plate coated on a first side with a second transparent conductor layer, the first side of the spacer plate facing the first side of the first substrate, the spacer plate having a second side opposite its first side;

plural spacers disposed between the first substrate and the spacer plate to define a predetermined gap between the first substrate and the spacer plate;

liquid crystal filled in between the first substrate and the spacer plate; and

a second substrate coated on a first side with a second reflector layer, the first side of the second substrate facing the second side of the spacer plate.

**23.** The optical cross connect according to claim 22, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is spaced a predetermined distance apart from the spacer plate.

**24.** The optical cross connect according to claim 22, wherein the second substrate of each of the liquid crystal Fabry-Perot etalons is disposed directly against the spacer plate.

**25.** A liquid crystal Fabry-Perot etalon comprising:

a first substrate formed of glass;

a spacer plate formed of glass;  
liquid crystal disposed between the first substrate and the spacer plate;  
a second substrate formed of glass, spaced apart from the spacer plate by an air gap;

a phase matched glass- liquid crystal interface reflective coating disposed on a first side of the first substrate, the first side of the first substrate facing the liquid crystal, wherein the phase matched glass- liquid crystal interface reflective coating comprises:

a reflector layer disposed on the first side of the first substrate;

a first tin-indium oxide transparent conductor layer disposed over the reflector layer; and

a first alignment layer disposed over the tin-indium oxide transparent conductor layer;

a first phase matched glass-air interface anti-reflective coating disposed on a second side of the first substrate opposite its first side;

a phase matched glass- liquid crystal interface anti-reflective coating disposed on a first side of the spacer plate, the first side of the spacer plate facing the liquid crystal, wherein the phase matched glass- liquid interface crystal anti-reflective coating comprises:

a second tin-indium oxide transparent conductor layer disposed on the first side of the spacer plate; and

a second alignment layer disposed over the tin-indium oxide transparent conductor layer;

a second phase matched glass-air interface anti-reflective coating disposed on a second side of the spacer plate opposite its first side;

a phase matched glass-air interface reflective coating disposed on a first side of the second substrate, the first side of the second substrate facing a second side of the spacer plate; and

a third phase matched glass-air interface anti-reflective coating disposed on a second side of the second substrate opposite its first side;

wherein the first and the second transparent tin-indium oxide conductor layers are each etched in a grid pattern so as to form multiple independent etalons.